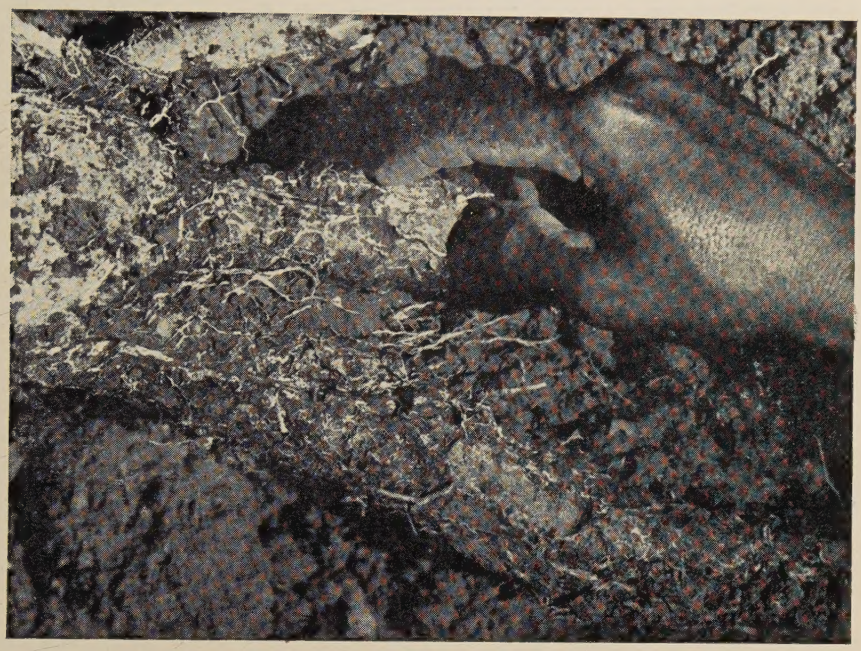
# PLANTERS' BULLETIN

## OF THE RUBBER RESEARCH INSTITUTE OF MALAYA



NEW SERIES NUMBER SIXTEEN

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# R R I

LOCATION. The institute's laboratories and offices are at the third mile, Ampang Road, Kuala Lumpur.

CORRESPONDENCE. All LETTERS must be addressed to the Director, Rubber Research Institute of Malaya, Post Office Box 150, Kuala Lumpur. Special inquiries may be marked for the attention of particular officers. The address for TELEGRAMS is Searching, Kuala Lumpur. TELEPHONE: Kuala Lumpur 3351. PARCELS occasionally arrive without any indication of their origin. Senders' names and addresses should be written clearly on the outside of all packages, and the institute should be advised of despatch by letter or telegram.

PROHIBITED PLANT SPECIMENS. Attention of planters and others in territories outside the Federation of Malaya and the Colony of Singapore is drawn to the Malayan Plant Importation Rules which prohibit the importation into Malaya of any part of a plant, whether living or dead, unless it is accompanied by a permit issued by the Director of Agriculture, Federation of Malaya. No permit will be issued in respect of any diseased plant or any plant pest. Any plant imported in contravention of these Rules (whose object is to prevent the introduction of diseases or pests) will be destroyed without examination. Anyone outside Malaya who desires our advice on any matter that may require examination of living material must first inquire by letter.

ADVICE. Inquiries are invited from rubber producers in the Federation of Malaya, the Colonies of Singapore and North Borneo, and the territories of Sarawak, Brunei and Nigeria, who may require more detailed information applicable to their own special problems. INTERVIEWS should be arranged by letter or telephone, as members of the senior research and advisory staff are frequently absent on visits to plantations. The institute is open from 8 am to 1 pm and 2 pm to 4 pm on Mondays to Fridays, and from 8 am to 12 30 pm on Saturdays.

EXPERIMENT STATION AND FACTORY. This station of the R R I is situated 16 miles from Kuala Lumpur, at Sungei Buloh on the Kuala Lumpur — Kepong — Kuala Selangor road. Visits may be made on Mondays or Wednesdays by arrangement. There is a guest house.

PUBLICATIONS. A list of 'Publications of the R.R I.' is available on request. Subscription may be made by depositing $15 with us. An annual statement of account will then be submitted.

# PLANTERS' BULLETIN

OF THE RUBBER RESEARCH INSTITUTE OF MALAYA

Kuala Lumpur January 1955 Number 16

## Editorial: More Rubber for Less Work

A previous *Editorial* remarked with some cogency that one of the critical and limiting factors in producing natural rubber to compete with synthetic rubber was the cost of production, and that the largest item in this cost was the labour of tapping. An obviously available way to achieve a reduction was pointed out in the same article, and that was to increase the yield of the individual tree. This has always been a most important aspect of the research programme of any institute dealing with an agricultural crop. Allied to this aim is that of protecting increased production by conferring disease resistance on the improved material.

A simple way of ennoblement that has been practised since man became an agriculturist is mass selection. In essence the progeny of the best individual from the unselected crop are used for the next planting. Before the advent of budding this method was used by rubber planters who wished to improve their seedlings, and when budding became a practical proposition it was possible to fix the desirable characteristics of any one seedling tree in a clone.

The results of this period are still with the industry, and represent the major proportion of the 'high-yielding' rubber quoted in the *Malayan Rubber Statistics Handbook*. The names are household words such as Tjir 1, Gl 1 and PB 86 in Malaya, LCB 1320 and 510 and GT 1 in Indonesia, and a host of others of less general value but of good performance on local sites. The Rubber Research Institute in its early days examined many thousands of mother trees, and established 235 new clones of which eleven have shown promise, but not sufficient to warrant large scale use. They have however been used in the next process of improvement.

The obvious sequel to mass selection is to cross by hand the first selections, and from their progeny to select a further series of material which combine the better qualities of the parents without their disadvantages, and with increased yield. At the same time as these parents' progeny are tested for use as seedlings, the seedlings are also cloned and tested, and thus double information is obtained. In the course of these investigations it was not always the best clone that produced the best progeny — a number of average clones produced outstanding progeny.

This method of improvement has proved fruitful, and among the results can be mentioned the recommended RRIM '500' series clones, certain of the Prang Besar and Chemara clones, the RRIM '600' series still under small scale test but very promising, and further series still under selection by the R.R.I. In Indonesia certain of the late AVROS clones may be good, as may be the PR series. The corresponding clones

from Ceylon and Indochina are the RLD series and the IR and TR series respectively.

All this second period of development has been hampered by the fact that the basic introduction of rubber into Malaya was from one particular area, in which the wild trees were only of moderate yield. Importations have been made from areas where the yield of the wild tree is reputedly twice that of Wickham's importations, and this consideration holds out hope that further development can continue at the same rate as hitherto.

In addition to the second method outlined, it has been discovered that inbred lines of rubber show a marked lack of vigour. This phenomenon indicates that there is hope of further improvement of the crop, in the same way that maize has been improved, by crossing inbred lines and inducing heterosis or hybrid vigour. If the new importations are suitable the chance of being able to do this is much greater. In this respect it is worth noting that the yield of maize has been doubled in some instances, and we have started on a minor programme to see if similar results cannot be obtained.

While the rubber tree suffers from no serious diseases in Malaya, the possible introduction of South American leaf blight is a constant threat, and apart from immediate phytosanitary precautions some long term defence measures have to be made. An exchange of clones was undertaken with the Instituto Agronomico do Norte, Brazil, and 25 resistant clones were obtained in exchange for 25 of our clones. Five of their clones are suitable for topbudding, and thus available for immediate use if required; all are resistant but not particularly high yielding and can be used for breeding.

What is required is a tree which approximates to the best in Malaya at present, but in which the factor for resistance has been implanted from the imported clones. This is theoretically possible by employing the breeding method known as backcrossing, provided that the progeny can be tested against the disease. The only suitable areas where the test can be carried out are in tropical America.

A final method of improving the material in Malaya is to exchange, without suspicion or reservation, the best and most promising clones in the country, with all other countries, and this farsighted move has been agreed with the Rubber Research Institute of Ceylon, the Algemeen Proefstation der A.V.R.O.S., the Proefstations der C.P.V. and the Institut des Recherches sur le Caoutchouc en Indochine. Twenty clones from each of the institutes named have been established in Malaya, with a few exceptions, for test and eventual free distribution when recommendations can be made. Twenty clones have been exported to each of the foreign institutes from Malaya.

It is hoped that this generous cooperation can be extended to the breeding programme to induce resistance to South American leaf blight, to prevent expense and unnecessary competition, and to speed up the eventual result.

This outline serves to show how the object mentioned in the first paragraph can be achieved. It is true that the Mission headed by Sir Francis Mudie implied in its report that if a proper replanting rate had been kept up with even the clones from mass selection, the cost of

production of both estates and smallholders would have been considerably reduced; yet it is obvious that if improved and higher yielding material can be offered for replanting, the same effect can be obtained by a smaller replanting. In any event the long term programme for disease resistance may be vital to the industry.

Objections might be raised to the programmes outlined on the score of expense. In this connection we reiterate the remark made in a previous *Editorial,* that the R.R.I. Experiment Station has since 1946 returned a total of 1.4 million dollars to the Malayan Rubber Fund in the form of income realised by the sale of rubber and planting material. Of the total area at present in tapping on the Experiment Station some 66% is, or has been, in use for experiments in breeding and selection.

Any proposal for further investigations of this nature implies therefore that some of the costs will be met, and that complete amortisation might be achieved within a reasonable time. It is indeed fortunate that experiments of this nature—of vital importance to the industry—are nearly self supporting and possibly in future profitable. There is indeed a case to be made for carrying on such work entirely on land under our own control, not only because of the economic angle, but also from the research aspects of rigid control and uniform treatment.

# RRIM '600' Series—Further Observations

A DESCRIPTION of clones RRIM 600 to 623 appeared eighteen months ago in *Planters' Bulletin 7.* This was based on observations from small scale trials of seven trees or less, for each clone. Such trials do not normally display the usual habit of the clone because of the effect of surrounding clones of different habits.

We can now present observations from plots on the large scale trials at our Experiment Station, Sungei Buloh, Selangor. These refer to the first selection clones, RRIM 600 to 618, at four years old, and to the second selection, RRIM 619 to 630, at just over three years old. In addition we present the yield records for 1953 from the small scale trials of all the clones. This supplements the table on page 74 of *Planters' Bulletin 7.*

These trials also provided information on wintering; for standards, our remarks refer to clones PB 86 and Tjir 1, which wintered during the last week in February, and towards mid-March, respectively. The selected clones appear to winter later than their parents. It must be understood that these observations are subjective and that what happened in these trials last season may not recur elsewhere at another season.

Girth measurements were taken in February 1954 on the two large scale trials at the Experiment Station. The first selection, RRIM 600 to 618, was cut back in April 1950 while the second selection RRIM 619 to 630, was cut back in December 1950. The figure for rank refers to girths, and two clones of the same girth therefore rank together. For comparison the girth of clone RRIM 501 was 11.9 inches in the first trial and 10.3 inches in the second.

The latices, rubbers and crepes of the clones are at present under intensive observation by the Chemical Division.

HABIT AND GIRTH

*RRIM 600* — A tall clone of average vigour and erect branching habit. The foliage is sparse. The crown is narrow and the trunk is straight, erect and smooth. The bark is very slightly bumpy. The clone winters at about the same time as Tjir 1. Our small scale trial suggested a liability to brown bast. (Girth at 4 years, 13.0 inches. Rank 10.)

*RRIM 601* — An upright very vigorous tree, fairly tall with erect branching and an average number of branches. The foliage is dense and the crown narrow. The trunk is straight erect, and the bark is smooth. The clone winters at the same time as clone Tjir 1 and appears to commence refoliation within one week. (Girth at 4 years, 13.5 inches. Rank 5.)

*RRIM 602* — A tall vigorous tree with erect branching habit, and an average number of branches. The foliage is dense; the leaf is dark green and glossy, typical of clone Gl 1. The crown is narrow, and the trunk is straight erect and smooth. The bark is smooth. The clone appears to winter about a week after clone Tjir 1. (Girth at 4 years, 13.6 inches. Rank 4.)

*RRIM 603* — A tall vigorous tree with erect and rather sparse branching habit but with heavy branches. In two severe storms that occurred in the trial during the last two years, the clone did not suffer breakage to any great extent, but a number of trees were bent and had to be pruned of the heavy branches, and roped. In a pure stand — not in one third acre plots — it might have suffered less. The foliage is light, and the crown narrow. The trunk is erect and the bark is corky, very similar to that of clone Pil B84. The union is inconspicuous. The clone winters after clone PB 86 but before Tjir 1. It is easy to bud. (Girth at 4 years, 14.1 inches. Rank 2.)

*RRIM 604* — A tree of below average vigour, with a spreading branching habit and an average number of branches. The foliage is not dense and the canopy is irregular. The crown is wide and globular, and the trunk is slightly curved and smooth. The bark is somewhat bumpy with slightly prominent buds. The clone winters shortly after clone Tjir 1 and commences refoliation within one week. The clone habit is good in the small scale trial, but its habit in the large scale trial is not encouraging. (Girth at 4 years, 11.7 inches. Rank 16.)

*RRIM 605* — A vigorous tree with a spreading dense branching habit which displays the heavy forking of clone Tjir 1. It has a heavy crown, and covers are suppressed in the plots in the large scale trial. The crown is globular and the trunk smooth. The bark is smooth and the buds are not prominent. The clone winters after clone PB 86 but before clone Tjir 1; it starts to refoliate within one week. (Girth at 4 years, 13.1 inches. Rank 9.).

*RRIM 606* — A tree of average vigour with a semi-erect and average branching habit, branching commencing early on the stem. The foliage is dense and the leaves are small—like those of clone Tjir 16—forming a closed canopy early in life. The crown is wide and fan shaped, and the trunk may be slightly crooked. The bark is smooth. The clone winters shortly after clone Tjir 1. (Girth at 4 years, 13.2 inches. Rank 8.)

*RRIM 607* — A tree of average vigour with a dense spreading branching habit, the branching occurring low on the trunk. The foliage is dense. The crown is wide and globular and the trunk is slightly curved.

Slight bleeding is apparent on the trunk. The bark is smooth with somewhat prominent buds. Wintering occurs before clone Tjir 1 but after clone PB 86; signs of refoliation may appear within a week. (Girth at 4 years, 12.6 inches. Rank 13.)

*RRIM 605 at 18 months on coastal soil*

*RRIM 606 at 23 months on inland soil*

*RRIM 608* — A tree of average vigour only, with semi-erect and fairly dense branching habit. The foliage is not dense. The clone is not easy to bud and so the stand in the observed plots is irregular. The trunk is a little curved but erect and smooth. The bark is slightly bumpy with some prominence of the buds. The clone winters shortly after clone Tjir 1. During the two bad storms mentioned some breakage of branches was apparent and a number of trees were bent. This clone is not as vigorous in the large scale trial as it appears in the small scale trial. (Girth 4 years, 11.6 inches. Rank 17.)

*RRIM 609* — This clone is one of the two least vigorous of the first selection, RRIM 600 to 618. The branching habit is erect and occurs high on the trunk with an average number of branches. The foliage is of average density, with a slightly yellow leaf. The crown is narrow and fan shaped, and the trunk is erect and smooth. The bark is slightly bumpy with some prominence of the buds. Wintering occurs a week or more after clone Tjir 1. (Girth at 4 years, 11.4 inches. Rank 19.)

*RRIM 609 at 23 months on inland soil*

*RRIM 610* – A clone of average vigour with a semi-erect and dense branching habit. The crown is wide and globular and the trunk is erect with a sign of fluting on some trees. The bark is slightly bumpy but the buds are not prominent. Wintering appears to occur a

week or more after clone Tjir 1, and new growth was evident a week after defoliation. (Girth at 4 years, 12.7 inches. Rank 12.)

*RRIM 611 at 23 months on inland soil*

*RRIM 611* — A clone of average vigour. The branching habit is erect and may be rather sparse; the foliage is not dense. The crown is narrow and fan shaped. The trunk is erect and smooth while the bark is smooth with slight protuberance of the buds. Wintering occurs a week or more after clone Tjir 1. (Girth at 4 years, 12.0 inches. Rank 14.)

*RRIM 612* — A vigorous clone with a semi-erect branching habit and dense branching. The crown is wide and globular and the foliage is dense. The clone sustained slight wind damage during the storms. The stem of the clone is distinctly wavy. It winters early, before clone PB 86. Girth at 4 years, 13.3 inches. Rank 6.)

*RRIM 612 at 23 months on inland soil*

*RRIM 614 at 23 months on inland soil*

*RRIM 613* — A very vigorous tree with erect branching and sparse heavy branches. Considerable pruning was necessary after storms had passed over the area of the trial and a number of trees were bent and required roping. The clone may be susceptible to wind damage. The foliage is rather sparse, the crown narrow and fan shaped. The trunk leans slightly; the bark is somewhat bumpy, with slight prominence of the buds. Wintering occurs after clone Tjir 1 and refoliation appears to begin within one week. A particularly easy clone to bud. (Girth at 4 years, 14.7 inches. Rank 1.)

*RRIM 614* — A tree of average vigour and a semi-erect branching habit. Both the branches and the foliage are dense. The crown is rather spreading. The trunk is erect and smooth, and some bleeding has occurred. The bark is a litle bumpy, and there is slight prominence of the buds. Wintering occurs before clone Tjir 1 but after clone PB 86, and refoliation may begin within one week. (Girth at 4 years, 12.9. inches. Rank 11.)

*RRIM 615 at 23 months on inland soil*

*RRIM 616 at 18 months on inland soil*

*RRIM 615* — A vigorous clone with an erect and very dense branching habit. The foliage is of average density, and the leaves are borne mainly at the top of the tree. The crown is narrow and fan shaped, the trunk smooth and erect. Wintering occurs a week or more after clone Tjir 1. The clone has proved somewhat difficult to bud. (Girth at 4 years, 13.3 inches. Rank 7.)

*RRIM 616* — A vigorous tall tree with an erect to semi-erect branching habit and heavy branches similar to those of clone Tjir 1. The foliage is dense, and the crown narrow to globular. The trunk is erect and smooth. During the two severe storms some breakage of branches and bending of the trunk occurred. The bark is very slightly bumpy. Wintering occurs a week or more after clone Tjir 1. This clone may be a little difficult to bud. (Girth at 4 years, 13.8 inches. Rank 3.)

*RRIM 617* — This clone is one of the least vigorous of the first selection, RRIM 600 to 618. The branching is not dense. The crown is wide and spreading; the trunk is slightly fluted. The bark is a little bumpy with slight prominence of the buds. Wintering occurs a week or more after clone Tjir 1. (Girth at 4 years, 11.7 inches. Rank 18.)

*RRIM 618* — A clone of average vigour with a sparse and spreading branching habit. The foliage is of average density. The crown is wide and spreading and the trunk is a little curved but erect. The bark is slightly bumpy but the buds are not prominent. Wintering occurs after PB 86 and before clone Tjir 1, and refoliation starts within one week. (Girth at 4 years, 11.9 inches. Rank 15.)

*RRIM 619* — This clone is of average vigour, with branches appearing fairly high on the trunk. The number of branches is average. The foliage is good and appears dense in some plots. The crown is wide and

fan shaped. The trunk is straight and upright, while the buds are not prominent, and the bark is smooth. Wintering was found to be uneven during the period under observation. (Girth at 3¼ years, 10.1 inches. Rank 9.)

*RRIM 620* — This clone varies in vigour from plot to plot, but on the whole it is above the average vigour for the trial. Branching occurs fairly low on the stem and the branches are semi-erect with drooping secondaries. The crown is wide and fan shaped. The trunk of most of the trees is slightly curved, but the trees remain upright. The buds are very slightly prominent, but the bark apart from this is smooth. Wintering occurs a week or more after clone Tjir 1. (Girth at 3¼ years, 10.9 inches. Rank 5.)

*RRIM 621* — The most vigorous clone of the second selection. Branching occurs fairly high up the trunk, and branches are numerous and dense. The foliage is of average density, and the whole crown is fan shaped. The buds are slightly prominent on some trees, but apart from this the the bark is smooth. Wintering occurs after clone PB 86 but before clone Tjir 1. (Girth at 3¼ years, 12.4 inches. Rank 1.)

*RRIM 622* — A vigorous to average clone with a dense semi-erect branching habit, and an average density of foliage. The crown is globular and narrow. The trunk may be slightly curved, but is upright throughout the trial. The buds are not prominent and the bark is smooth. Wintering occurs after clone PB 86 but before clone Tjir 1, and refoliation may be complete within one week. (Girth at 3¼ years, 10.9 inches. Rank 5.)

*RRIM 623* — This clone has a tall habit, and is almost as vigorous as clone RRIM 621. The branching is dense and somewhat upright, with drooping secondaries, and the foliage is dense. The trunk is straight and upright. In effect the crown gives a globular impression. The buds are not prominent and the bark is smooth. Slight bleeding has occurred on some trees high up on the trunk. Wintering occurs at the same time and is similar to that of clone Tjir 1. (Girth at 3¼ years, 12.0 inches. Rank 2.)

*RRIM 624* — This clone is not vigorous, and in some cases the trees appear weak. The crown is wide and fan shaped, with branching average to sparse, and average foliage. The trunk at this age appears slightly crooked. The buds are not prominent and the bark is smooth. Wintering occurs before clone PB 86. (Girth at 3¼ years, 10.1 inches. Rank 9.)

*RRIM 625* — A vigorous tree, with a narrow and fan shaped crown and an average number of branches which are erect. The stem on certain trees may be slightly crooked, but all trees are upright, and the majority are smooth. The buds are very slightly prominent, otherwise the bark is smooth. Some slight bleeding is apparent below the first branches. Wintering occurs a week or so after clone Tjir 1, and refoliation commences rapidly, within one week. (Girth at 3¼ years, 11.2 inches. Rank 3.)

*RRIM 626* — This clone is of slightly more than average vigour for the trial, with a diffuse globular crown. Branching is average, and the foliage is little better than sparse. Many of the trees are curved, while some lean slightly. The bark is smooth. Wintering occurs at the same time as clone Tjir 1. (Girth at 3¼ years, 10.7 inches. Rank 6.)

*RRIM 627* — A clone of more than average vigour with a wide fan shaped crown, and an average branching habit and foliage. The trunk

is upright, the leaf scars not prominent, and the bark is smooth. Wintering occurs a week or so after clone Tjir 1, and refoliation commences rapidly, within one week. (Girth at $3\frac{1}{4}$ years, 11.0 inches. Rank 4.)

*RRIM 628* — A clone of less than average vigour, with a wide and fan shaped crown. Branching occurs fairly low on the stem and is dense. The foliage is also dense. The trunk is straight and upright, and some bleeding is apparent below the first branches. The bark appears to be slightly bumpy on most trees. Wintering occurs a week or so after clone Tjir 1. (Girth at $3\frac{1}{4}$ years, 10.5 inches. Rank 7.)

*RRIM 629* — The least vigorous clone in the trial. The crown is narrow and fan shaped, with a dense semi-erect branching habit and average foliage. The stem is upright. The buds are not prominent and the bark is smooth. Some bleeding is apparent on the trunk. Wintering is indefinite. (Girth at $3\frac{1}{4}$ years, 9.8 inches. Rank 10.)

*RRIM 630* — A clone of below average vigour for the trial, with a globular crown. Branching is sparse, and the foliage is little better than sparse. The trunk is upright and the bark is smooth. The clone winters as clone Tjir 1. (Girth at $3\frac{1}{4}$ years, 10.2 inches. Rank 8.)

YIELDS OF RRIM '600' SERIES CLONES. 1953

| *Clone* | *Parentage of mother tree* | *Yield* | |
|---|---|---|---|
| | | *lb/tree* | *year of tapping* |
| *RRIM 600* | *Tjir 1 × PB 86* | 31.1 | 7 |
| *RRIM 601* | *Tjir 1 × Gl 1* | 20.6 | 7 |
| *RRIM 602* | *Tjir 1 × Gl 1* | 21.7 | 7 |
| *RRIM 603* | *PB 86 × Pil B84* | 26.5 | 7 |
| *RRIM 604* | *Tjir 1 × PB 49* | 20.1 | 7 |
| *RRIM 605* | *Tjir 1 × PB 49* | 24.2 | 7 |
| *RRIM 606* | *Tjir 1 × PB 49* | 19.6 | 7 |
| *RRIM 607* | *Tjir 1 × PB 49* | 25.3 | 7 |
| *RRIM 608* | *AVROS 33 × Tjir 1* | 28.7 | 7 |
| *RRIM 609* | *AVROS 157 × BD 5* | 20.8 | 7 |
| *RRIM 610* | *RRIM 504 × Tjir 1* | 27.4 | 7 |
| *RRIM 611* | *RRIM 504 × Tjir 1* | 32.9 | 7 |
| *RRIM 612* | *AVROS 157 × PB 49* | 34.3 | 7 |
| *RRIM 613* | *Tjir 1 × RRIM 509* | 15.6 | 7 |
| *RRIM 614* | *Tjir 1 × RRIM 509* | 20.5 | 7 |
| *RRIM 615* | *RRIM 511 × Tjir 1* | 30.4 | 7 |
| *RRIM 616* | *Tjir 1 × RRIM 507* | 18.8 | 7 |
| *RRIM 617* | *BR 2 × RRIM 500* | 20.6 | 6 |
| *RRIM 618* | *Lun N × RRIM 501* | 26.5 | 6 |
| *RRIM 619* | *RRIM 501 × Tjir 1* | 12.3 | 7 |
| *RRIM 620* | *RRIM 501 × RRIM 511* | 21.7 | 7 |
| *RRIM 621* | *RRIM 504 × Tjir 1* | 20.9 | 7 |
| *RRIM 622* | *Tjir 1 × Pil B84* | 28.3 | 6 |
| *RRIM 623* | *PB 49 × Pil B84* | 27.7 | 7 |
| *RRIM 624* | *Tjir 1 × RRIM 529* | trees slashed | |
| *RRIM 625* | *Tjir 1 × RRIM 526* | trees slashed | |
| *RRIM 626* | *Tjir 1 × RRIM 500* | trees slashed | |
| *RRIM 627* | *Tjir 1 × RRIM 526* | trees slashed | |
| *RRIM 628* | *Tjir 1 × RRIM 527* | 15.0 | 4 |
| *RRIM 629* | *Tjir 1 × RRIM 529* | 15.0 | 4 |
| *RRIM 630* | *Tjir 1 × RRIM 527* | 15.4 | 4 |

# Cultivating Other Crops with Rubber

*We have pleasure in presenting a guest article by the Senior Agronomist of the Department of Agriculture. The various crops which may be planted between widely spaced rubber rows are discussed. The article deals with those crops which need no large amounts of bulky organic manures. A further article will be devoted to crops which depend on mixed farming. Both should interest especially those planters who are experimenting with hedge planting.*

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THE DIVERSIFICATION OF MALAYAN PLANTATION AGRICULTURE is clearly sound policy in order to reduce dependence on natural rubber and vegetable oils. The practice of catchcropping young rubber with short term crops is well known in Malaya and the emphasis in the past has been on bananas, gambier, pineapples and tapioca. However, this has sometimes led to soil erosion, the encouragement of lalang and stunted growth of young rubber. On the other hand catchcropping by Chinese with well manured vegetables and foodcrops often benefits the growth of the main crop and good results have been reported from Indonesia with catch crops of Robusta coffee. The practice of hedgerow planting of rubber, with single and double hedges spaced perhaps a chain apart, permits permanent intercropping and this is the system which will be discussed.

To consider the merits or disadvantages which are claimed for hedgerow rubber planting is to invite controversy; nevertheless a proper understanding of these claims is essential before mixed cropping can be planned. The advantages are summarised below:

*1* Hedgerow planting exposes a greater leaf area to light which is said to increase photosynthesis.

*2* Close spacing within hedges increases the efficiency of labour utilisation.

*3* Supervision is simplified.

*4* When the time comes to replant, this operation is made easier since the young hedges are planted down the centre of the interrows and it may prove possible to bring these into bearing, after heavily pruning the old rubber, while keeping the latter in tapping.

*5* If hedgerows are aligned east and west the interrow strips are supplied with plenty of sunlight and mixed cropping is thereby possible. If the intercrop chosen is a leguminous creeping cover, that cover will not be shaded out by the mature rubber.

*6* The system clearly improves aeration and may assist in control of diseases of the tapping panel.

*7* Even in its simplest form, where natural weeds are allowed to grow in the interrow strip, the system amounts to crop rotation which may assist in control of root diseases.

Obvious disadvantages of hedgerow planting are:

*1* Very close spacings within the row are said to have led to poor tree conformation and low early yields.

*2* If root disease occurs, spread of that disease along the rows may be rapid.

*3* Advantages *1* and *5* are not fully compatible: the first is optimum with north and south planting; the other with an east and west row alignment.

*4* Advantage *1* is offset because the trees take longer to produce a continuous canopy so that light is wasted in the early years. The amount of light absorbed is that which falls on the area less that which reaches the ground.

It can be argued from the advantages claimed for hedgerow planting that the requirements of a successful intercrop are as follows:

It should not grow as tall as the rubber and its root system should be different.

It should be tolerant of partial shade.

It should not be more susceptible than hevea to the diseases which they have in common.

Harvest of the intercrop should not damage the rubber roots or induce soil erosion or deterioration of soil structure.

It should not be slow maturing or, like coconuts, have a longer economic life than rubber.

Many planters would probably add that the intercrop should be as easy to grow and establish as rubber but to accept that would make this article superfluous, since all but one or two forest crops would be eliminated. This emphasises the importance of soil type, since few crops will thrive on the poorer rubber soils or on land which has been subject to sheet erosion. Experimental intercultivation should be largely confined to the richer soils which have a history of good management.

Bearing in mind the danger of excessively close spacing within the hedgerows, the system taken as standard for the purpose of this article is a double row of young rubber planted 7 ft × 7 ft triangular, with the double row centres 66 feet apart. This gives an initial stand of 188 trees per acre and an interrow strip of just under 60 feet wide.

## CHOICE OF INTERCROP

The following crops can be cultivated without large quantities of bulky organic fertilisers.

| | |
|---|---|
| Liberian coffee | Oil palms |
| Robusta coffee | Kapok |
| Cacao | Fruit Trees |
| Manila hemp | Sisal |
| Bananas | Mauritius hemp |
| Pineapples | Patchouli |
| Derris | Legume leys |
| Gambier | Balsa |
| Tea | Yemene |

*Liberian Coffee* — This is extensively grown on the alluvial mucks and organic clays of the Selangor coast, where it is normal to grow it either as a sole crop or interplanted with coconut palms. Liberian coffee sells readily on the local market but it cannot be exported to Europe, where this bean type is not acceptable. An export trade with India or

China might be built up but that would require market research. Meanwhile net imports to Malaya are considerable and the local markets are far from saturation.

Since shading reduces yield, rubber hedges should be planted east and west where Liberian coffee is to be intercropped. *Figure 1* shows a suitable planting plan.

R R R R R R R R R R R R R R R R R
R R R R R R R R R R R R R R R R R R
C C C C C C
Co Co Co Co Co
Co Co Co Co Co
Co Co Co Co Co Co
Co Co Co Co Co Co
Co Co Co Co Co
Co Co Co Co Co
Co Co Co Co Co Co
C C C C C C
R R R R R R R R R R R R R R R R R R
R R R R R R R R R R R R R R R R R R
20 feet

*Figure 1. Planting plan for rubber and Liberian coffee.*
*R = rubber 7ft × 7ft triangular; rows 66ft apart.*
*Co = permanent coffee, 11ft × 11ft triangular.*
*C = temporary coffee.*

Seed is sown in shaded nurseries 2 to 3 inches apart and germination commences after about 6 weeks. When the young seedlings have three or four pairs of true leaves above the cotyledons they should be transplanted into lightly shaded nursery beds at a spacing of about 1 ft × 1 ft. When the young plants are about 18 inches tall they are lifted carefully with a ball of earth around their roots and transplanted into their permanent quarters. Young plants should be manured as for young rubber. The crop comes into bearing after four years. Clean weeding is always practised since cover crops reduce yield. This means that the crop is less suited to fertile undulating soils than to alluvial bog soils. Mature coffee does not usually respond to fertilisers but local information is lacking on this point.

*Robusta Coffee* — This crop grows quite well on the better Rengam series soils and it may be assumed that it will grow even better on Segamat and Kuantan series soils. These last, however, are limited in extent in so far as existing rubber estates are concerned and there would be little point in growing Robusta coffee on a soil which would grow good crops of cacao.

In Europe this coffee commands good prices but, although it yields much less than Liberian coffee in Malaya, local prices favour the latter. For this reason it cannot be recommended for cultivation in this country. Robusta type coffee grows and yields well at moderate altitudes in Indonesia but it is grown there on rich volcanic soils and the seasonal climate suits the crop. Experiments at Serdang have shown that this coffee responds markedly to mulching but that the order of yield even from mulched plots on Kedah series soil makes it uneconomic to grow.

*Cacao* — West African Amelonado cacao seems a suitable crop to grow on Rengam series and volcanic soils, and also on the better Kedah series soils. Whether it would be equally successful when interplanted with hedgerow rubber can only be determined by experiment. It is probably safe to say that cacao and rubber cannot be intercultivated at orthodox spacings but that further trials are justified on the hedgerow system. Quick growing leguminous shade trees must be planted and established before cacao nurseries are laid down, since inadequate shade is usually fatal to cacao. Suitable shade species are *Erythrina subumbrans* (the thornless dadap), *Gliricidia sepium*, and vigorous bananas such as pisang awak. A planting plan is suggested in *Figure 2*.

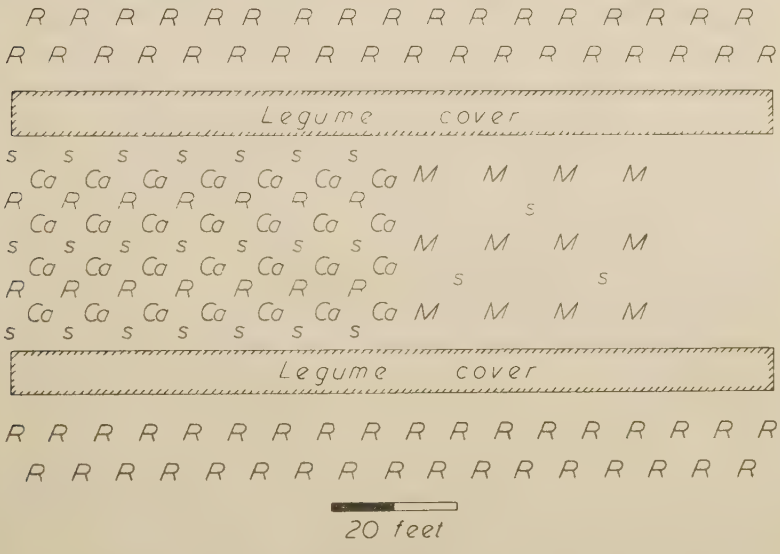


*Figure 2. Planting plan for rubber and cacao or Manila hemp.*
*R = rubber 7ft × 7ft triangular; rows 66ft apart.*
*Ca = cacao.*
*M = Manila hemp (or bananas).*
*s = shade : Erythrina or Glyricidia.*

Special mention must be made of lateritic or Malacca series soils on which it is the practice to manure both young and mature rubber on a generous scale. In both Malacca and Negri Sembilan, intercultivation trials suggest that cacao and rubber together thrive better on such soils than on many less stony soils; possibly the answer to this lies in the

relatively restricted rubber root system. However, it is only fair to add that cacao on a degraded Malacca series soil in north Kedah is showing poor growth.

The future of cacao is almost certainly much sounder than for coffee since the present world shortage is bound to last long, whereas a succession of good coffee crops in Latin America might well change a sellers' market into a buyers' one.

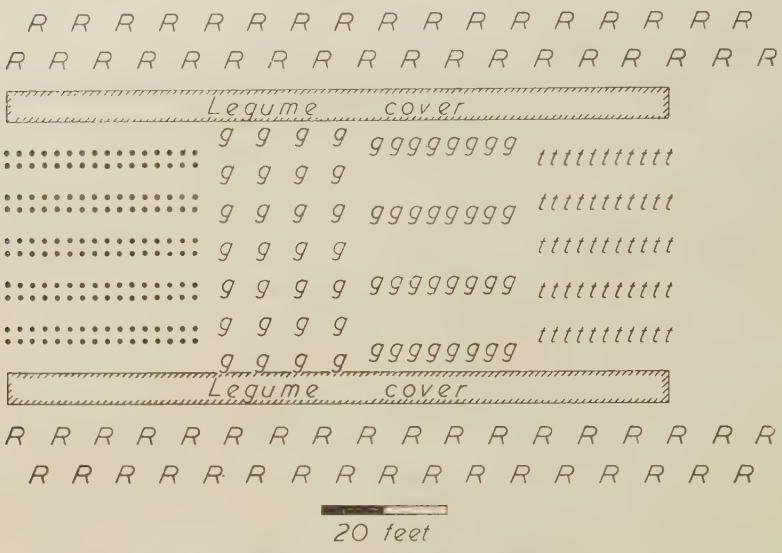


*Figure 3 Planting plan for rubber and pineapples, gambier or tea.*
R = *rubber 7ft × 7ft triangular; rows 66ft apart.*
• = *pineapples.*
g = *gambier, 6ft × 6ft, or 3ft × 11ft.*
t = *tea, 2ft × 7ft.*

*Manila Hemp* — On the better drained alluvial mucks and organic clays, on volcanic soils and possibly on Rengam series soils, Tangongon Manila hemp can be recommended for trial intercultivation with rubber. A suitable planting plan is given in *Figure 2*. This crop has the advantage of requiring only a modest outlay in factory machinery since $600 (Malayan) would cover the cost of a Hagotan stripper and of various hand tools, in addition to which a source of power would be required.

It is most important that only the Tangongon variety should be planted since others have proved to be less economic. Present prices for Manila hemp are good and the rope factory in Singapore will facilitate disposal of small quantities of fibre.

Manila hemp, like bananas, requires clean weeding and mulching so it is not suitable for hilly land except where adequate measures can be taken against erosion, such as silt pitting and contour ridging. Early management should aim at encouraging quick growth of the young plants so that they will soon smother all weeds.

*Bananas* — On Rengam series and more fertile soils, with good road access to a large town, the cultivation of bananas could be considered. The most profitable variety to grow is pisang embun but it is absolutely essential to use only clean planting material, free from Panama disease. This can be done by taking corms for planting from clumps that have already born good fruit bunches. Since it is normally impossible to purchase large quantities of disease free planting material the area cultivated should be built up gradually in order to prevent infection. The Manila hemp planting plan in *Figure 2* would also be suitable for bananas. The economic duration of a banana crop is not known but manurial trials are in progress in order to study this aspect. Regular manuring would almost certainly be required in order to maintain yields.

*Pineapples* — The Singapore canning pine grows well on peat soils and is for consideration where rubber is grown on shallow peats or mucks. A suitable planting plan is given in *Figure 3*. Canning pineapples should only be grown within reasonable distance of a cannery. Manurial requirements of pineapples on peat are being investigated but the following interim schedule should give good results.

| *Time of application* | *Fertiliser* | *Rate per acre* |
|---|---|---|
| 1-2 mths after planting | sulphate of ammonia | 100 lb |
| | Christmas Island rock phosphate | 60 lb |
| | muriate of potash | 60 lb |
| 6-7 mths after planting | muriate of potash | 60 lb |
| 11-12 mths after planting | muriate of potash | 60 lb |
| After each crop | sulphate of ammonia | 100 lb |
| | Christmas Island rock phosphate | 60 lb |
| | muriate of potash | 100 lb |

One intercultivation experiment with rubber spaced 12 ft × 20 ft on a shallow peat has yielded 78,994 lb per acre of fruit from five crops harvested between March 1951 and July 1953. This is equivalent to 15,799 lb per acre per crop, or 31,598 lb per acre per annum.

*Derris* — Several varieties of *Derris elliptica* make excellent creeping covers and the cultivation of this crop would be possible on most rubber soils. However, derris should only be grown on light friable soils since the roots have to be forked out by hand and the cost of this operation is prohibitive on any but freely worked soils.

The technique of planting is to root stem cuttings in shaded nursery beds and to plant these out at a distance of 2 ft × 3 ft apart when vigorous roots have been formed. Manuring with rock phosphate is recommended. The root should be harvested when $1\frac{1}{2}$ to 2 years old and it is then sun dried and baled for transport. There is a ready demand for root, and prices are favourable. Price depends on rotenone content and recommended varieties are Changi No. 3, and Sarawak Creeping. Mechanised harvesting might be feasible, but for this purpose the crop would need to be grown on ridges. Derris could be grown throughout the interrow strip so that it completely replaces the normal creeping cover. The rows closest to the rubber hedges would probably have to remain uncropped so as to avoid damage to rubber roots when harvesting.

*Gambier* — This crop is grown for its leafy twigs which are harvested at regular intervals. On extraction with boiling water they yield the cube gambier of commerce, which is used in the tanning industry. The crop is well suited to Rengam series soils but cannot be recommended for eroded or the less fertile rubber soils. Seedlings are raised in a lightly shaded nursery and transplanted out in rows 6 ft × 6 ft apart when about 6 months old. The first crop of leaves is taken about 15 months after transplanting and thereafter harvesting is carried out every four months. Since large quantities of green matter are removed it is essential that the crop be manured heavily and regularly to avoid exhausting the soil. The following annual applications of fertiliser have given good results on lowland tea and may be recommended for gambier:

| | *lb/acre* |
|---|---|
| sulphate of ammonia | 600 |
| rock phosphate | 100 |
| muriate of potash | 50 |

These should be given in two or three dressings per year.

Great care should be taken to avoid erosion and, with this end in view, hedge planting might be adopted on slopes with the gambier bushes spaced 3 ft × 11 ft. Two alternative planting plans are given in *Figure 3*.

*Tea* — Lowland tea has a longer economic life than rubber and for this reason is not considered a suitable crop to interplant with rubber. It requires good treatment when young and is relatively expensive to establish. It is not known for certain if tea and rubber will thrive together but there is no real reason why they should not do so provided that the tea is manured generously with nitrogen. A suitable planting distance for the lowlands is $3\frac{1}{2}$ ft × $4\frac{1}{2}$ ft but hedge planting at 2 ft × 7 ft might be worth a trial (*Figure 3*). Manuring should be at least as heavy as for gambier.

Economic units for black tea manufacture are of necessity large because of the high capital cost of the factory. However, if smaller areas are cultivated the crop could be marketed as Chinese green tea, since the Malayan Department of Agriculture have recently devised improved methods of manufacture. Nevertheless the market for green tea is limited and overproduction should be avoided.

*Oil Palms* — Oil palms could probably be intercultivated with rubber but this practice is unlikely. There might be some increase in biological efficiency, whereby two acres of mixed crop would yield more than one acre each of the two crops. Against that hypothetical gain is the known disadvantage of spreading the area over which an efficient transport system would be necessary; transport requirements are much greater for oil palms than for rubber because of the greater weight transported from field to factory. Furthermore the association of these two crops deprives the hedgerow system of advantages *1* and *6* mentioned above.

The economic unit for oil palm cultivation is larger than for rubber, so intercultivation could only be practical on the larger estates. Since most palms have relatively inflexible branching and rooting systems they cannot be grown in anything approaching a hedge. A suitable spacing for an intercrop would therefore be one row equidistant from the rubber hedges, with palms not closer than 27 ft within the row. With correct manuring oil palms can be established on poorer soils.

*Kapok* — This tree crop has been mentioned as a possible intercrop for the richer rubber soils. Two varieties are available, the local kapok with horizontal branches, and imported kapok with ascending branches. The local variety cannot be recommended for general estate cultivation since it requires both a river alluvial soil and a seasonal climate. The imported variety yields a large crop and has much longer pods; it seems to be somewhat more adaptable as to soil but more information is required on this point. If it were to be cultivated on estates suitable distances would be 18 ft to 20 ft apart in single row.

Kapok gives one crop a year, usually in April in Perak. The ripe pods are plucked from the trees with long handled pruners. Care is taken to avoid letting the floss drop on to wet ground since this reduces its value. Harvest is thus a tedious job, more suited to smallholders than to estates, and crops should therefore be sold on the tree.

*Fruit Trees* — All high value fruit trees require careful manuring and upkeep and specialised marketing facilities. Most require a richer soil than is usual for rubber; several need regular postharvest pruning. Perhaps the only ones that can be considered promising are budgrafted rambutans and, in the monsoonal north only, local or Tahiti limes and grapefruit. On deep, rich, moist soils both durians and mangosteens would succeed but they have the disadvantage of slow maturation — nearly twice that of rubber — and a longer economic life. The large fruited Italian lime is quite easy to cultivate and limited numbers can be sold as lemons to Europeans, but Asians prefer the small fruited varieties.

Fruit crops require plenty of light for good cropping and ripening; not more than one row should be planted in the interhedge strip and no attempt should be made to grow a close hedge. Details of cropping are given below.

| *Fruit* | *Spacing within rows* | *Planting material* | *Recommended clones* |
|---|---|---|---|
| Rambutan | 30 ft | budded plants | R 1,4,6,9,84 |
| Local lime | 18 ft | rooted cuttings | Li 4 |
| Tahiti lime | 18 ft | rooted cuttings | Li 1 |
| Italian lime | 18 ft | rooted cuttings | Li 3 |
| Grapefruit | 20 ft | budded plants | G.F.5 |
| Durian | 20(40)ft* | budded plants | any |
| Mangosteen | 15(30)ft* | seedlings | — |

**i.e. planted close for rapid early growth and later thinned out*

*Sisal* – Sisal in Malaya produces fibre of good quality which is readily saleable in London in large quantities. There are certain objections to the crop, namely intolerance of shade and bad drainage, need for replanting about every ten years, advisability of rotation, and the relatively high labour cost of weeding and harvesting. The latest factory installation is efficient but its cost cannot be met by catch crops. Apart from this, sisal is not subject to disease and it appears to grow well on relatively poor soils provided only that these are well drained and protected against erosion.

Trials in East Africa have shown that young sisal must be kept free from weeds for the first 2 to $2\frac{1}{2}$ years since these compete for soil moisture in the drier months. Once the crop is well established and about

five feet high it can compete with a selected soil cover provided that lalang and all creeping plants are kept down. Clean weeding the young crop necessitates considerable silt pitting on undulating land.

When a sisal plant flowers at about ten years old the flowering stem or 'pole' is about 25 feet tall. The flowers do not normally produce fruit but small plantlets or bulbils are born in the axils of the flower stalks and these later fall to the ground to provide a source of planting material. Bulbils are planted in unshaded nursery beds one foot apart and left to grow into small plants for 9 to 15 months. With good drainage, nursery technique is easy and 100 per cent establishment normal. The young plants are then transplanted in the field in double rows spaced 5 ft × 5 ft triangular, with 8 ft strips between the double rows. A planting scheme for a 40 year rubber cycle is suggested:

Year 0 Plant rubber and three double rows of sisal.

Year 1 Budgraft rubber.

Year 10 Collect bulbils and plant in nurseries, eradicate sisal by hormone spray; establish legume covers.

Year 15 Plough in legumes and plant out two double rows of sisal.

Year 25 Eradicate sisal and establish legume covers.

Year 30 Plough in legumes and plant out a single row of sisal.

Year 40 Eradicate sisal and plant second crop of rubber in its place.

A planting plan for the first two sisal crops is given in *Figure 4*. Some staggering of cropping is clearly required in order to provide suitable planting material at the correct times. However, since each plant that poles will produce at least 1,000 bulbils the provision of planting material on an established plantation is a simple matter.

A well managed crop of sisal comes into bearing three years after planting and should then be harvested every six months. A yield per acre of 1,000 to 2,000 lb of dry fibre can be expected from the fifth year onwards, from a pure crop. Fibre prices for British East African No. 1 have varied from £12 to £13 per ton in London about 1936, to £245 per ton in 1951, and £90 per ton in 1954.

The minimum factory requirements are 'Raspador' decorticators, brushing machines, a plentiful supply of clean water, and a source of power.

*Mauritius Hemp* — The cultivation of Mauritius hemp, *Furcraea gigantea,* is in many ways similar to that of sisal. It differs, however, in the following respects:

*1* It is tolerant of shade. In Mauritius it thrives under light shade provided by Lamtoro, *Leucaena glauca,* but it is also planted under firewood plantations of *Casuarina* and *Eucalyptus* spp. For this reason it may be expected to tolerate some degree of light competition from rubber hedges.

2 In past trials at Serdang yields of fibre have been rather less than from sisal because of the lower fibre content in the leaf. The best varieties yield 2½ to 3 per cent of fibre as compared with 3½ to 4 per cent from sisal.

*3* The fibre is somewhat less hard than sisal and is thus less suitable for rope making, although it can be used for twine. Unlike sisal it can also be used to make excellent, hard wearing bags—over one million sugar bags are produced annually in Mauritius.

*4* The plant is larger than sisal and a spacing of 6 ft × 6 ft triangular is recommended, with double rows spaced 9 to 12 ft apart.

Sisal decorticators are not suitable for Mauritius hemp but intensive development work is in progress in Mauritius and fairly satisfactory decorticators are in use.

This crop clearly deserves attention only when world supplies of jute are limited or highly priced. Furthermore it cannot be considered a complete jute substitute since it could not be spun in Dundee jute mills without major re-tooling.

A small intercultivation trial of Mauritius hemp with rubber and leguminous shade trees was planted on poor soil at Serdang in 1953 and this may be expected to come into bearing in 1956.

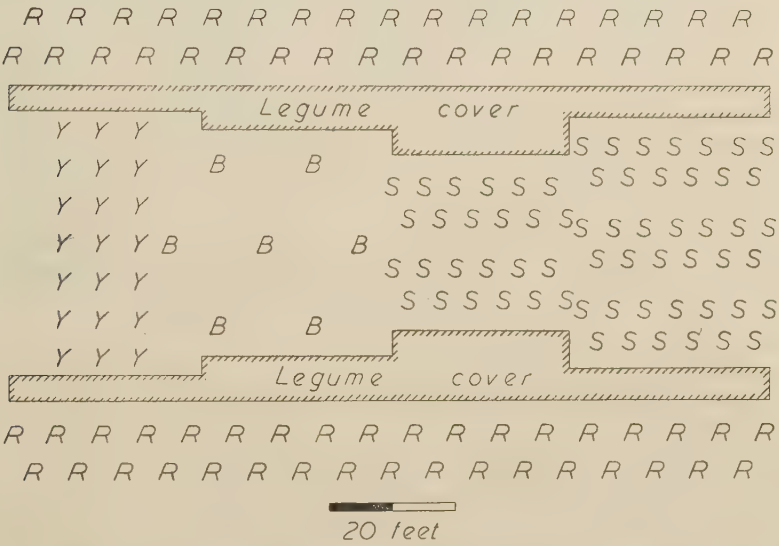


*Figure 4. Planting plan for rubber and sisal or forest crops.*
R = *rubber 7ft × 7ft triangular; rows 66ft apart.*
S = *sisal, 5ft × 5ft triangular; with 8ft strips between.*
B = *balsa, 15ft × 15ft*
Y = *yemene 6ft × 6ft.*

*Patchouli* – This thrives on rich, virgin, free draining, moist loams and makes an excellent catch crop with young rubber. On virgin soil it can be planted 3 ft × 3 ft or 3 ft × 2 ft apart, but on less fertile soils a closer spacing is desirable. Cuttings are rooted on site in lightly shaded nursery beds and then planted out into the field. The first crop is given 6 to 7 months later and subsequent crops at similar intervals. Replanting is required after the third crop on virgin soil; on less fertile soils it may be necessary after each crop. Subsequent plantings on the same land are never so healthy as the first crop, so that rotation is indicated. Patchouli is clearly more suited to catchcropping with young rubber than to intercultivation over an extended period. Rotation with derris might be suitable but has not been tested.

At the present time cultivation in Malaya is almost confined to Johore and Trengganu but there is a keen demand for leaf, which sells readily in Singapore.

*Legume Leys for Fodder* — Since *Centrosema pubescens* is both an excellent cover crop for rubber and also good fodder, a pure stand of it can be used for mixed farming, either as cut fodder or for grazing on site with tethered animals. The green fodder has a digestible protein content of about 4.1 per cent and it is relished by cattle and goats and can be fed to pigs. Care should be taken not to overgraze or to cut too close to the ground since either practice encourages such pernicious weeds as *Mimosa pudica* and invasion by grasses. 'Stylo', *Stylosanthes gracilis,* is under trial in Kedah and Kelantan and shows great promise as fodder. It gives good yields on poor soils with careful management, and may be harvested every two months by cutting at not less than 6 inches above ground level. The supply of seed is at present limited.

*Balsa* — On rich freely drained loamy soils balsa, *Ochroma lagopus,* might succeed as an intercrop with rubber. Trials by the Malayan Forest Department have shown promise and it has grown well at Serdang. Seedlings are raised in nursery boxes and pricked out into baskets at the four leaf stage. Basket plants can be planted out in the field when $1\frac{1}{2}$ to 2 ft tall, the spacing being 15 ft $\times$ 15 ft. Generous treatment of young plants is recommended and they could be given the same manurial application as for young rubber. Planting holes may be manured with rock phosphate and compost or cattle manure. Bare root seedlings are not easy to establish, so basket planting is recommended.

The estimated yield of timber in Ceylon after five or six years is 4,825 cubic feet of light trade balsa. No information appears to be available on the coppicing capacity of balsa but the Forest Department are investigating this.

*Yemene* (*Gmelina arborea*) — This timber tree grows fast on a wide range of soils and coppices strongly. Seed is readily obtainable and the timber can be used for firewood, matchwood, plywood and perhaps for paper pulp. It is not recommended for alluvial or peaty soils or for very sandy and lateritic soils. Its only disadvantage is that is does not tolerate competition for the first 12 to 18 months, but once the canopy closes it smothers out weeds.

The recommended spacing is 6 ft $\times$ 6 ft, using seedling stumps. The recorded yield of firewood in Malaya from 4 to 5 years old plants is 1,490 cubic feet per acre, solid volume, or 2,070 cubic feet, stacked volume. The optimum harvesting period would be after about 8 years. All coppice growth should be allowed to develop after harvest in order to shade out weeds but progressive thinning to two to three shoots per point is recommended according to vigour.

A firewood or pulpwood crop is of relatively low value so plantations should be sited with good market access and the Forest Department should be consulted at all stages.

## DISCUSSION

A certain farming practice can only be recommended when it has been thoroughly tested by field experiments and when the results have been checked by costing trials on estates. Unfortunately the Department of

Agriculture is not in that happy position in respect of any form of intercropping with hedgerow rubber. The intercultivation systems mentioned in this article must therefore be considered experimental but they can best be tested by simple trials on estates. Perhaps the most promising intercrops on suitable soils are Liberian coffee, cacao, Manila hemp, bananas, pineapples and gambier. However, meticulous attention must be paid to their agronomic requirements.

Two intercrops which can be grown with hedgerow rubber but which have been excluded from consideration are ipecacuanha and rubber clonal seedlings. The former thrives on well drained muck soils under shade but planting material is in such short supply that extensive planting is not now possible, while the production of clonal rubber seedlings is well understood by planters but does not achieve diversification.

Two forest crops have been included with some diffidence; one of these is possibly the only tree—other than rubber—which is worth trying on the poorer soils. Planters interested in their cultivation should consult the Forest Department. A third forest crop, *Albizzia falcata*, could be grown for pulp or matchwood, even on relatively poor soils, but it has been excluded from consideration because of its susceptibility to red root disease.

*I am indebted to Mr F.H. Landon, Acting Chief Research Officer, Forest Department, for information on the technique of planting the forest crops, and to many members of my own Department for useful ideas on the other crops.*

E.F. ALLEN

# Replanting a Bad Root Disease Area

*These observations are based on a report prepared for an estate where the amount of root disease had raised doubts as to the desirability of replanting the old rubber. Background information is contained in an article that appeared in Planters' Bulletin 10.*

ON THE ESTATE IN QUESTION the 1948, 1949, 1951 and 1953 replantings had in common that the old rubber was cleared by poisoning the standing trees with sodium arsenite, without distinguishing between the diseased and the healthy. Further, a mixed legume cover of *Pueraria* and *Centrosema* was planted and became well established, though the 1953 replanting also carried *Mikania* and some grasses. As usual, the *Pueraria* was dominant at first and was the first to become shaded out. At the time of inspection, June 1954, it provided a dense cover in the 1951 replanting, but had been largely replaced by *Mikania* in the 1948 and 1949 areas, while a 1947 replanting had many indigenous growths.

Recent evidence has shown that legume and other creepers can transmit infection when allowed to grow unrestricted round the collars of the young trees. Creepers make an excellent cover but ring or strip weeding are advisable wherever there is much root disease.

The planting distance in all the replantings was 7½ feet between budded trees in rows 40 feet apart, giving a full stand of 145 per acre. The

desired increase in initial stand with clonal seedlings was provided by planting two lines of trees in the row, with 6 feet between them, the intention being to keep only the better tree of each pair for tapping. The initial planting of clonal seedlings was thus 290 per acre, to be selectively thinned to 145 during immaturity. With both types of planting material it was intended to have only about 120 trees per acre by the time tapping commences.

Some tree losses through root disease can generally be accepted without sacrificing crop. However, as root disease losses may involve adjacent trees, unless control measures are properly carried out, the result may be the desired stand per acre but with a distribution far from uniform.

Information provided by the estate as to losses due to root disease may be summarised as follows. In the 1951 replanting losses had been few; in the 1949 replanting about 10 per acre, and in the 1948 replanting about 40 per acre. A progressive rise with increasing age is to be expected; yet an exceptionally low incidence was observed in the 1947 replanting. This was readily explained because the area had been replanted twice—once immediately before the Japanese occupation, which the trees were too young to survive, and again after it. When the first replanting died out, and the remains of the old trees rotted away, the disease died out too. A 1941 replanting that survived the neglect of the early years had a high incidence of infection, as was to be expected. Loss of stand continues indefinitely in such an area unless the disease can either be eradicated or isolated by trenches. The latter course costs less initially but it entails the loss of all trees within the bounding trenches (even though some of them could otherwise be saved) and the recurring charge of reopening the trenches every two years or so.

The heavy losses in the estate's 1948 replanting had already reduced the density to below what was intended; a count recorded only 94 trees per acre. Combined with the fact that losses were already occurring in the 1953 replanting this showed the need for close attention to control measures in the young rubber. The task is of sufficient importance to justify employing skilled labourers on the work. A digression on the three operations involved—inspection, treatment, and eradication of the sources of infection — may be helpful.

### CONTROL MEASURES IN YOUNG RUBBER

First, collar inspection. Using hardwood stakes minimises injury to the roots in exposing them for inspection. When employing only the wooden stakes the work proceeds slowly and may degenerate into little more than scratching at the surface. A changkol blow or two, placed radially to the tree so that the chance of cutting a lateral root is small, can speed up the work if the soil is in the right condition. Clay soils are difficult at all times.

Second, treating diseased trees. Overmuch emphasis is often put on washing the roots with 2% copper sulphate solution. The important step is pruning off and burning diseased roots. With a very young tree there is not much else that can be done. With a larger one it may be possible to save some part of an infected root. Where the fungus is only superficial it can be stripped off and the root washed with the copper sulphate solution as a further precaution. Only a limited amount of cutting

into the collar region to excise infection can usefully be done. A tree that has had extensive treatment, which incidentally takes a considerable time, has a poor chance of surviving. A heavy incidence of disease should be compensated by more frequent rounds of inspection and treatment, so that cases are detected before the infection has become far advanced. If nothing is done until losses look like becoming excessive, too strenuous efforts to save every tree are likely to be made.

Third, eradicating sources of infection. In a mechanically cleared area the infective sources are mostly scattered root fragments. In poisoned areas, where the root systems of the old trees have remained undisturbed, the sources are mostly the lateral roots of diseased stumps. If one plant becomes diseased its neighbours probably will too. An isolation trench dug round a diseased young tree will certainly include the immediate contact source of infection, but it will probably leave more infective material outside. The diseased tree should be regarded as an indicator of the presence of a source of infection, which should be traced out and disposed of. When the source is a large stump it will be cheaper and still effective to remove and burn the lateral roots, leaving the bole isolated while it rots away.

## PREPARING AREAS FOR REPLANTING

The high incidence of disease in this estate's post war replantings raised doubt as to future policy. There are in general three courses that can be justified in various circumstances. First, if the disease risk is small, the old stand can be cleared without attempting eradication. Even then the stumps should be poisoned if the trees are felled. Second, if the risk is altogether too high, planting an alternative crop must be considered. Third, in the intermediate situation, the area can be replanted with rubber provided that the bulk of the disease in the old stand is eradicated.

To arrive at an opinion for the case in question the amount of disease in the old stand has to be assessed preferably relating it to the past situation in the rubber which was replaced by the 1947-53 replantings. The only available indication lay in comparing stand per acre, supposing losses to have been mostly due to root disease. This view was well supported by the visual impression of numerous vacant patches, some very large, many running together. The following were the figures for the original stand per acre in the various areas:

1948 replanting — 40, counted in 1947;
1949, 1951, 1953 replantings — 80, estimated in 1947;
1955 replanting — 30, counted in 1954;
later replantings — 60, counted in 1954.

A stand of 80 per acre in the fields that became the 1949, 1951 and 1953 replantings may have been overestimated, but it seems significant that there was a heavy incidence of disease in the 1948 area which was replanted from fields with a much lower stand per acre than those cleared later. On this basis, if the same method of clearing were to be followed in the replanting planned for 1955, root disease would be expected to be rather worse than in the 1948 area.

Whether this may be held to justify abandoning rubber cultivation in the area depends on the price put on the cost of eradicant measures.

We have had no practical experience of the use of heavy tractors, but it is understood that the total cost of complete mechanical clearing is of the order of $250 (Malayan) per acre. The figure covers felling, stacking for burning, ploughing, harrowing, tining to bring out root fragments, their collection and burning. Clearing with winches worked by hand labour costs almost as much to do a less thorough job. The most efficient method of felling, if the area to be dealt with is large enough, employs two heavy crawler tractors joined by a cable that pulls over three rows of trees in one operation.

Various advantages other than the improvement in the root disease situation accrue from clean clearing, but it does not reduce expenditure on root disease control in the young stand to nothing. Even if it did, complete mechanical clearing could hardly be justified for root disease control alone, as it is not possible to foresee a like amount of money being spent on post-planting measures following on the cheapest of clearing methods. The annual expenditure per acre on root disease control in the estate's 1948 replanting did not approach this level:

| Year | 1950 | 1951 | 1952 | 1953 | Total |
|---|---|---|---|---|---|
| $ per acre | 2 | 11 | 32 | 22 | 67 |

A compromise solution was proposed whereby mechanical clearing would be carried out along the planting rows only. Assuming straight planting with 40 feet between rows, and taking for argument a figure of $240 per acre for mechanical clearing of a stand of 60 trees, the cost of completely clearing 13-foot planting strips may be calculated as follows. The total cost can in this instance be reduced to allow for the low stand of only 30 trees per acre (not perhaps by a half but by say 25%), and then divided by three in the proportion of the cleared area to the whole, to give $60 per acre. The rest of the trees, diseased or not, would be poisoned, adding about $5 per acre to the clearing costs.

In the first two years after planting the disease position would be much the same as if the whole area had been cleared. Incidence might still be high but sources could be eradicated cheaply. Thereafter the stumps would be the chief sources of infection but by that time they would have become partially rotten and easy to deal with. The following estimate of the cost of post planting root disease control takes these considerations into account.

| Year | 1 | 2 | 3 | 4 | 5 | Total |
|---|---|---|---|---|---|---|
| $ per acre | 5 | 20 | 30 | 15 | 10 | 80 |

The above reasoning gives a figure of $145 per acre for dealing with root disease in those heavily infected fields, as an estimate that might be used in calculations as to whether replanting with rubber is economic or not in that particular situation.

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R R I M '600' Series— *Tables of yield, girth, virgin bark, and bark renewal, are available on application. Budwood of these clones cannot be supplied again before April 1955.*

## Freeing of RRIM '500' Series Clones and of Clone LCB 1320

THE BOARD OF THE RUBBER RESEARCH INSTITUTE OF MALAYA is pleased to remove all restrictions on the sale of budwood of the RRIM '500' series clones in Malaya, British North Borneo, Sarawak and Brunei, with effect from 1 January 1955. All sales agreements relating to budwood of these clones are therefore cancelled and producers are free to purchase or sell the budwood within the territories abovementioned.

Authentic budwood of the clones will continue to be available from the nurseries of the Rubber Research Institute Experiment Station, Sungei Buloh, Selangor, at a cost of $5 per yard f.o.r. Sungei Buloh. A Certificate of Origin will be supplied with each consignment of budwood purchased direct from the R.R.I. No sales agreement need be entered into when purchases are made.

THE BOARD OF THE RUBBER RESEARCH INSTITUTE OF MALAYA further announces that, by agreement with the Board of the Central Proefstations Vereniging, clone LCB 1320 is similarly freed from all restrictions in Malaya, British North Borneo, Sarawak and Brunei, as from 30 June 1955.

Authentic budwood of this clone will continue to be available from the Rubber Research Institute Experiment Station and will be supplied with a Certificate of Origin. No sales agreement will be necessary, and the cost remains the same as that of budwood of the RRIM '500' series clones.

## RRIM '600' Series Clones Trials on Estates

Further trials of these clones will be established this year, and the cooperation of estates and agencies is urgently sought. To represent the series adequately we need an additional three trials on coastal soils and two on inland soils.

Proposed areas should be reasonably uniform, an area of about 21 acres is preferable. The trees should be ready for budding, or transplanting as budded stumps, during 1955. Budwood for these trials will have priority and cost 20 cents per yard. Please write as soon as possible.

THE PHOTOGRAPH ON THE COVER SHOWS ABUNDANT RHIZOMORPHS OF FOMES LIGNOSUS ON A DISEASED RUBBER ROOT

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